Academia Sinica Press Release

Strong Evidence Brown Dwarfs Do Form Like Stars

Astronomers from the Institute of Astronomy and Astrophysics (ASIAA) have uncovered strong evidence that brown dwarfs form like stars. Using the Submillimeter Array (SMA, is a collaborative project of the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy & Astrophysics), they detected molecules of carbon monoxide being ejected from an object known as ISO-Oph 102. Such molecular outflows are typically seen coming from young stars or protostars; however, this object has an estimated mass of 60 Jupiters, meaning it is too small to be a star. Astronomers have classified it as a brown dwarf.

Brown dwarfs are on the dividing line between planets and stars, and generally have masses between 15 and 75 Jupiters. They are sometimes called failed stars. However, it is not clear whether they form like stars, from the gravitational collapse of gas clouds, or if they form like planets, agglomerating rocky material until they grow massive enough to draw in nearby gas.

A star forms when a cloud of interstellar gas draws itself together through gravity, growing denser and hotter until fusion ignites. If the initial gas cloud is rotating, that rotation will speed up as it collapses inward, much like an ice skater drawing her arms in. In order to gather mass, the young protostar must somehow shed that angular momentum. It does so by spewing material in opposite directions as a bipolar outflow.

A brown dwarf is less massive than a star, so there is less gravity available to pull it together. As a result, astronomers debated whether a brown dwarf could form in the same way as a star. Previous observations provided hints that they could. The serendipitous discovery of a bipolar molecular outflow at ISO-Oph 102 offers the first strong evidence in favor of brown dwarf formation through gravitational collapse and fragmentation.

“We thought that any such outflow would be too weak to detect with current facilities and would have to wait for a next-generation instrument like ALMA [the Atacama Large Millimeter Array],” said Ngoc Phan-Bao of the ASIAA, first author of the paper announcing the find. “This was a big surprise. Finding the molecular outflow with the SMA shows the extraordinary capabilities of the array and this significantly advances our knowledge of brown dwarf formation.”

As might be expected, the outflow contains much less mass than the outflow from a typical star: about 1000 times less, in fact. The outflow rate is also smaller by a factor of 100. In all respects, the molecular outflow of ISO-Oph 102 is a scaled-down version of the outflow process seen in young stars.

“These findings suggest that brown dwarfs and stars aren’t different because they formed in different ways,” said Academician Paul Ho, director of the ASIAA and an astronomer at the Harvard-Smithsonian Center for Astrophysics. “They share the same formation mechanism. Whether an object ends up as a brown dwarf or star apparently depends only on the amount of available material.”

The paper on ISO-Oph 102 will be published in the December 20 issue of the Astrophysical Journal Letters.

Further information:
Dr. Paul Ho is the Director and Distinguished Research Fellow of the ASIAA.
Dr. Ngoc Phan-Bao is a Visiting Scholar (Postdoctoral Fellow of Dept. Physics, Univ. of Central Florida) at ASIAA.

Media Contacts:
Dr. Ngoc Phan-Bao, Visiting Scholar (Deptartment of Physics, University of Central Florida) at ASIAA, Academia Sinica
(Tel) 886-2-3365-2200 #824
Dr. Pin-Gao Gu, Assistant Research Fellow at ASIAA, Academia Sinica
(Tel) 886-2-3365-2200 #748
Mei-Hui Lin, Public Relations Office, Central Office of Administration, Academia Sinica
(Tel) 886-2-2789-8821, (Fax) 886-2-2782-1551, (M) 0921-845-234

Attached Picture’s Caption: An Artist's conception of the brown dwarf ISO-Oph 102. Observations by the Submillimeter Array suggest that it is forming like a star, by accumulating material from the surrounding accretion disk (orange) shown here. The brown dwarf sheds angular momentum by ejecting material in two oppositely directed jets (red). Blue bow shocks indicate where those jets are interacting with the interstellar medium. Credit: Y.C. Tsai/ASIAA